PROTOPLASM

As regards Protoplasm, in relation to Professor Huxley's Essay on the Physical Basis of Life. Pp. 68. By James Hutchinson Stirling, F.R.C.S., LL.D., Edinburgh. (Blackwood and Sons. 1869.)

WHEN one of the most powerful representatives of the Transcendental school of philosophy, himself possessing a knowledge of biological science, consents to do battle against the modern doctrines concerning Life and its assumed material substratum, *Protoplasm*, we may expect, at least, that the strongest arguments which can be adduced will be brought to bear against the obnoxious theories and their supposed materialistic tendencies. Still more especially must we prepare ourselves for battle *à outrance*, when the champion that steps forward is one who has already grappled so manfully with the "Secret of Hegel" and is otherwise so distinguished a leader amongst the adverse school of thinkers.

Although differing altogether from Prof. Huxley on the main subject of his essay, we find that in one respect the opinions expressed therein are perfectly in accordance with those of Mr. Stirling. With reference to the views enunciated concerning Comte and his writings, Mr. Stirling says: "I acknowledge in Mr. Huxley's every word the ring of a genuine experience." Mr. Stirling is even more severe on the hitherto much-lauded Positive philosopher than Prof. Huxley himself. He says:—

> There is not a sentence in his book that, in the hollow elaboration and windy pretentiousness of its build, is not an exact type of its own constructor. On the whole, indeed, when we consider the little to which he attained, the empty inflation of his claims, the monstrous and maniacal self-conceit into which he was *exalted*, it may appear, perhaps, that charity to M. Comte himself —to say nothing of the world—should induce us to wish that both his name and his works were buried in oblivion.

When the phrase "Physical Basis of Life" was employed, this was intended to convey the notion that there was one kind of matter, that is, one genus—including an almost infinite number of specifically different, though closely related, kinds—common to all living beings: this matter being named Protoplasm. In connection with this doctrine, though based upon other facts, there was a further inference. Life was believed to be a function of living *matter* rather than of living *form*—whether cellular or other. No secondary visible organisation, at all events, was supposed to be needed, though a primary but invisible *molecular* organisation was deemed all essential for the display of vital manifestations. Such a doctrine being once admitted, there is, as Mr. Stirling points out, no logical halting-place short of Prof. Huxley's further conclusion, "*that all vital action whatever, intellectual included, is but the result of the molecular forces of the protoplasm which displays it.*"

Let us see, then, what is to be said in favour of a *matter* of Life, and how far Mr. Stirling's objections to this doctrine are valid.

At the time when the doctrines of Schleiden and Schwann—that the 'cell' was the ultimate morphological unit capable of displaying 'vital' manifestations—were announced, and long after, the simplest independent living things, whether animal or vegetable, were supposed to be unicellular organisms. *Form* and visible organisation were, therefore, regarded by most as necessary for the manifestation of Life: it was supposed that a more or less spherical structure was needed, possessing a distinct cell-wall, with a nucleus, and other cell contents. But, of late years, increasing knowledge and faithful investigation has necessitated much change of doctrine, in regard to the nature of those simplest parts of complex organisms which are capable of displaying a vitality of their own, and in regard to the nature of the simplest independent living things.

Some of the principal modifications in the 'cell' doctrine of organisation are thus sketched by Mr. Stirling himself:—

> The first step taken in resolution of this theory was completed by Max Schultze, preceded by Leydig. This was the elimination of an investing membrane. Such membrane may, and does ultimately form; but, in the first instance, it appears the cell is naked. The second step in the resolution belongs, perhaps, to Brücke, though preceded by Bergman, and though Max Schultze, Kühne, Haeckel, and others ought to be mentioned in the same connection. This step was the elimination, or at least subordination, of the nucleus. The nucleus, we are to understand now, is necessary neither to the division nor to the existence of the cell.
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> Thus, then, stripped of its membrane, relieved of its nucleus, what now remains of the cell? Why, nothing but what *was* the contained matter, the intracellular matrix, and *is*—Protoplasm.

Thus, then, we seem to reach our elementary life-stuff—our living *matter*. But Mr. Stirling would warn us against coming to any such conclusion—he will not so easily yield. He tells us we are quite wrong if we think we have got rid of the cell and have reduced ourselves to a simple matter of Life. And why? "Because," as he says, "all the great German histologists still hold by the cell, and can hardly open their mouths without mention of it." But, if this be so, after what Mr. Stirling has himself told us, to what else can we ascribe the practice, save to a seeming reality of that reputed fondness in the German mind for courtesy or conventional titles? Some such excuse there may be, but assuredly no other. We would ask Mr. Stirling to reconsider the bearing of the statements which he has himself adduced. In place of the old morphological vital unit—the cell—with its definite characters, we are reduced to a mere naked, non-nucleated bit of protoplasm, as the simplest material substratum adequate to display all those vital manifestations, previously considered to be the essential attributes of the formed elements above mentioned. The power of displaying vital manifestations has, in fact, been transferred from definitely formed morphological units, to utterly indefinite and formless masses of Protoplasm. Instead, therefore, of an obvious *form* of Life, we are reduced to a *matter* of Life, presenting no appreciable morphological characters. It becomes evident, moreover, that if the old term "cell" is still applied to these mere bits of living stuff or protoplasm—not because they are morphological units, but simply because biologists have been compelled to transfer the power of manifesting vital characteristics to such indefinite protoplasmic masses—then this term, thus employed, must be seen to have so entirely lost its old signification, that it can be regarded only as a mere courtesy title. Vital power has obviously been transferred from a definite morphological unit—the cell—to mere living matter, and if any people do persist in still calling a portion of such mere matter by the name of the morphological unit, simply because this was of old also *assumed* to be the vital unit, *we* must not allow such mere confusion in language to confuse us as to the real facts and inferences.

There is another point of view, also, to which Mr. Stirling does not seem to have given an adequate attention. The old doctrine did well enough at a time when the lowest known living things were "unicellular organisms," closely approximating in their characters to those morphological units of which the higher plants and animals are built up. But, since our knowledge has increased—since we have become more familiar with the various living things constituting the lowest groups of Professor Haeckel's third organic kingdom—PROTISTA—the maintenance of such doctrines has become impossible. Do we not now know that although the *Protoplasta* are amœboid animals possessing the old cell characters—that is, having a distinct nucleus, and a definite bounding membrane—there are, nevertheless, adult animals, leading an entirely independent existence, composing the lowest group *Monera*, some of which have no bounding membrane, though they have a nucleus, whilst others, simpler still, are mere bits of protoplasm—naked, non-nucleated, structureless? Yet, such minute, homogeneous, and altogether indefinite bits of protoplasm, are as capable of displaying the fundamental characteristics of life, as are the more definite unicellular organisms to which such attributes were formerly supposed to be restricted. Without visible structure, they nevertheless assimilate materials from their environment, and grow; they constantly vary their shape, and are capable of executing slow movements; though possessing no nucleus, they are able to divide and reproduce their kind.

It seems only fair to mention in this place, that so far back as 1853, before the doctrine as to the constitution of the "cell" had undergone such a modification, or rather, as we should have said, before it had been generally acknowledged that vital manifestations could be displayed by mere bits of protoplasm lacking the supposed necessary elements of *form*, Professor Huxley had put forth a powerful remonstrance against the then all-prevalent "cell theory" of organisation.* His opinions were announced even five years before Virchow, the last great champion of the doctrine, issued his celebrated "Cellular Pathologie." Following, in the main, the doctrine of Wolff and Von Baer, Prof. Huxley contended that the primitive organic substance is a homogeneous plasma, in which a certain differentiation takes place, but that there is no evidence whatever to show that the molecular forces of this living matter ("vital forces" of most modern writers) are, by this differentiation, localised in any one part rather than in any other part—be it cell, or be it intercellular tissue. "Neither is there any evidence," he says, "that any alteration or other influence is exercised by the one over the other; the changes which each subsequently undergoes—though they are in harmony—having no causal connection with one another, but each proceeding, as it would seem, in accordance with the general determining laws of the organism." Whilst believing that the *periplast*—corresponding with the cell-wall and intercellular tissue of other writers—is the seat of all the most important metamorphic processes out of which the various tissues are produced, he also believes that this differentiation is not brought about by any mysterious action on the part of the cell or nucleus, but that it is rather the result of intimate *molecular* changes taking place in the plastic matter itself, after a definitely successive though inexplicable fashion. Prof. Huxley's fundamental position was, in fact, that "the primary differentiation is not a *necessary* preliminary to further organisation—that the cells are not machines by which alone further development can take place; they are rather mere indications of accustomed modes of evolution." This main position he has further illustrated by saying: "We have tried to show that they [the cells] are not instruments, but indications—that they are no more the producers of the vital phenomena than the shells *scattered in orderly lines* along the sea-beach, are the instruments by which the gravitative force of the moon acts upon the ocean. Like these, the cell only marks where the vital tides have been, and how they have acted."

Certainly the essence of this doctrine is, that the vital forces are "molecular forces"—that they are not dependent upon morphological forms or "cells" and, therefore, that essentially vital manifestations may take place in mere formless living matter—Protoplasm, if you will. As we have just seen, this is precisely the doctrine to which so many other distinguished biologists have now given in their adhesion. They too—Max Schultze, Haeckel, Kühne, and others—have gradually recognised that a something of definite form is no longer necessary: that there are independent living things, even lower in the scale than the old "unicellular organisims": that to constitute one of these, or to constitute a vital unit of one of the higher living things, all that is needed is mere formless, indefinite Protoplasm—or, as Mr. Stirling contemptuously expresses it, a mere "shred" of the matter of Life.

Much of what immediately follows, in Mr. Stirling's essay, we consider to be somewhat irrelevant. We think it has been written under the influence of a misconception as to Professor Huxley's real meaning. Mr. Stirling argues against Protoplasm, on the assumption of its being a substance definite in kind—as definite, we may say, as chloride of sodium—whilst apparently, Professor Huxley's meaning was rather that Protoplasm was the name of a genus of matter, or else of a species including almost innumerable varieties: that it was a proteinacious substance, in fact, of which there might be as many hundreds of isomeric modifications, as there are similar varieties of protein itself.

We regret that we are unable to follow Mr. Stirling into this second part of his essay. It seems to us to be the most interesting part of it, and we recommend our readers to study it for themselves. Much, however, of its reasoning, is, for us, deprived of its seeming cogency, because we cannot agree with Mr. Stirling in his previous conclusion as to the non-existence of a matter of Life. This, as he fully admits, is the really fundamental question about which the difference of opinion exists. And, if we cannot agree with him upon this first point, it is useless for us to follow him into his subsequent reasonings. We cannot, however, but admire his candour when he says:

> It is to be acknowledged . . . that Mr. Huxley would be very much assisted in his identification of differences, were but the

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* Brit. and For. Med. Chir. Review, 1853, p. 306.

theories of the molecularists* on the one hand, and of Mr. Darwin on the other, once for all established. The three modes of theorising indicated, indeed, are not without a tendency to approach one another; and it is precisely their union that would secure a definitive triumph for the doctrine of materialism. Mr. Huxley, as we have seen—though what he desiderates is an autoplastic living *matter* that, produced by ordinary chemical processes, is yet capable of continuing and developing itself into new and higher forms—still begins with the egg. Now, the theory of the molecularists would, for its part, remove all the difficulties that, for materialism, are involved in this beginning; *it would place protoplasm undeniably at length on a merely chemical level; and would fairly enable Mr. Darwin, supplemented by such a life-stuff, to account by natural means for everything like an idea or thought that appears in creation.*

Nothing could be more outspoken and candid than this utterance of Mr. Stirling. He evidently believes that such doctrines of the "molecularists" concerning the new evolution of living things will have long to "await the proof"; but we, on the contrary, firmly believe the time to be not far distant when this will be as much an accredited dictum of science as are the other doctrines of the Correlation of the Physical Forces, and of the Correlation of the Vital and Physical Forces which have been its necessary predecessors. We would ask the Transcendentalists, at least, to speculate upon the possibility of this. Let them learn in the meantime how they may best readjust their doctrines, so that when the time comes in which such change will be absolutely necessary—if their views are to be in accordance with the established truths of science—there may be no sudden bewilderment, no feeling as if the very ground were being swept from underneath their feet. To such a thinker as Mr. Stirling, we should imagine the necessary modification of doctrine would not prove difficult. For, after all, the acceptation, to the fullest extent, of the doctrines concerning Life to which we have been alluding, involves, even from the Transcendentalists, only a somewhat different point of view. So long as Matter, and Force or Spirit, are but two aspects of a something one and indivisible, there is still room for opposite philosophical systems. The old questions may be discussed as earnestly as ever by those who have the leisure and the taste for such ontological inquiries. And, if perchance lured into such discussions, it would often be found that he who was most vehemently charged with Materialism would, from an ontological point of view, prefer to rank himself amongst those who professed the principles of a pure Idealism.

H. CHARLTON BASTIAN

AGRICULTURAL CHEMISTRY

How Crops Grow: A Treatise on the Chemical Composition, Structure, and Life of the Plant, for Agricultural Students. By Samuel W. Johnson, M.A., of Yale College, U.S. Revised, with numerous additions, and adapted for English use, by A. H. Church and W. T. Thiselton Dyer. 1 vol. 8vo., pp. 399. (London, 1869.)

THIS revised edition of an excellent American work ought to find its way into the hands of a very numerous class of youths whose future avocations will require a special acquaintance with the phenomena concerned in the growth of plants—either naturally or under the influence of cultivation—some familiarity with the general structure of plants, with the functions of their several organs and the nature of the various materials which it is the work of vegetation to produce for the food of animals and for numerous other purposes.

It is surprising that in a country where the practice of agriculture is one of the chief sources of wealth and is, directly or indirectly, the means of employing a vast amount of capital and labour, very little should have been done towards the scientific elucidation of agricultural practice so as to ensure improvement of the art. Yet such is still the case in this country with some rare exceptions like the experimental farm at Rothamsted, where Messrs. Lawes and Gilbert have done so much to aid the farmer in applying manures and cattle-feeding materials to the best advantage. The Royal Agricultural Society, the Highland Agricultural Society, and the Agricultural College at Cirencester, have also contributed towards the attainment of the same object; but, as a rule, agriculture is practised almost exclusively under the guidance of mere traditional principles and habitual routine, without those engaged in this business having any appreciation of the phenomena and natural laws which govern the growth of plants, even so far as they are known to science. This fact is, in part, no doubt a consequence of the general disregard of scientific teaching in this country; but it is also referable in some degree to the absence of any organised scientific investigation of plant-life in relation to agriculture, such as that carried on of late years in Germany by the aid of the various governments and with the hearty support of farmers. It is indeed strange that in a country like ours, where agriculture is no longer a mere

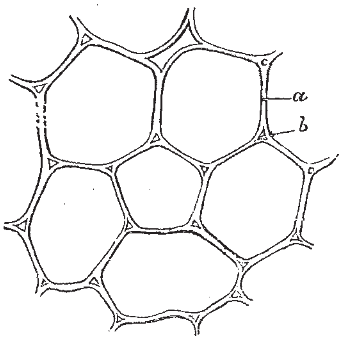

Fig. 1.—Section of cells in a cabbage stem, shewing at *a* the union of the cell-walls and the intercellular spaces at *b*.

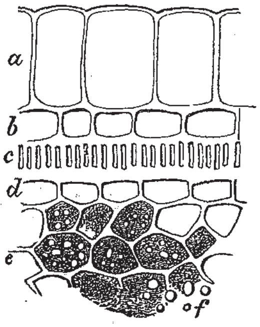

Fig. 2.—Section of a flax-seed, highly magnified, exhibiting *a* cells containing mucilage, *e* cells containing caseine and drops of oil *f*.

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* Mr. Stirling so designates those who believe in the possibility of an evolution of living things; or, in other words, those who believe in the possibility of a so-called "spontaneous generation."